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Water security challenges and the CERC programme at the U of S

Howard Wheater

Canada Excellence Research Chair in Water Security

howard.wheater@usask.ca

Saskatchewan Institute of Agrologists

Saskatoon

15 March 2011

'Water' has many meanings

Water is fundamental to society's basic needs:

- **Clean drinking water**
- **Food** – 70-80% of the world's water use is for irrigation
- **Energy** production – hydropower and cooling for thermal stations; but water supply and treatment is a major energy user
- **Industry**
- **Environment**
- **Floods** are one of the world's biggest natural hazards

Water security – a working definition

"sustainable use and protection of water resources, safeguarding access to water functions and services for humans and the environment, and protection against water-related hazards (flood and drought)."

Global water challenges and the perfect storm

Current issues:

- 900 million lack access to clean drinking water
- 1.4-2.1 billion live in water stressed areas
- unsustainable use of water – declining groundwater levels, dry rivers
- increasing competition for water resources – at local, regional and international scales
- degradation of water quality – from over-abstraction and pollution

And the future:

- increased demand – population growth, economic development, agriculture, energy
- environmental change

  -land use and land management change

  -climate change

6 billion in water-scarce areas by 2050?

Some implications:

- Society has reached the limits of demand-driven water management
- Issues of sustainability must be addressed – these include trans-boundary issues
- Complex problems of uncertain water futures must be confronted and managed
- A consistent societal agenda is needed for water, food and energy, addressing both climate change adaptation and mitigation

Water is rising up the political agenda and increasingly making news

The New York Times 26 September 2010:

The New York Times

Middle East

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION

AFRICA AMERICAS ASIA PACIFIC EUROPE MIDDLE EAST

Egypt and Thirsty Neighbors Are at Odds Over Nile

Max Becherer for The New York Times

A farmer hauling a load of grass to feed animals across a bridge spanning the Nile River, vital to Egypt's water needs. More

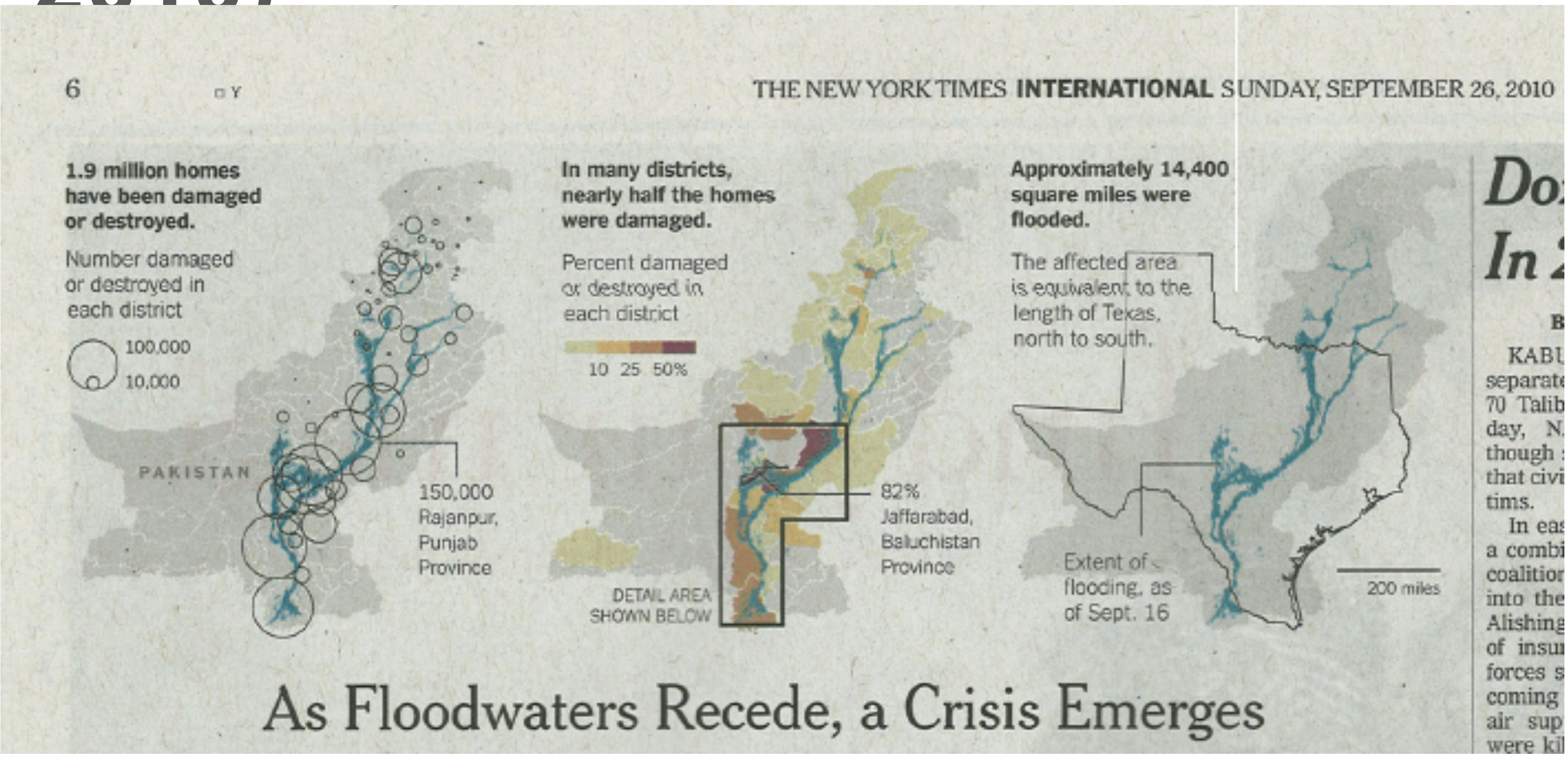
Egypt and Thirsty Neighbours At Odds Over Nile

‘Upstream countries, looking to right what they say are historic wrongs, have joined in an attempt to break Egypt and Sudan’s near-monopoly on the water, threatening a crisis that Egyptian experts said could, at its most extreme, lead to war.....’

Egypt and Thirsty Neighbours At Odds Over Nile

'In Egypt, decades of bellicose rhetoric about the Nile have made the river's water an explosive issue. "**Violating Egypt's quota of Nile water is a genocidal war against 80 million people**," an Egyptian commentator, Hazem el-Beblawi, wrote this year in Al Masry Al Youm, an Egyptian daily.'

New York Times (26 September 2010)



As Floodwaters Recede, a Crisis Emerges

'Two months after flooding began in the northern reaches of Pakistan, the waters of the Indus continue to flood low-lying areas of Sindh....The flooding killed about 1,800 people, and more than 20 million people ... have been affected. The United Nations estimates that 12.4 million people are in need of immediate humanitarian assistance.....'

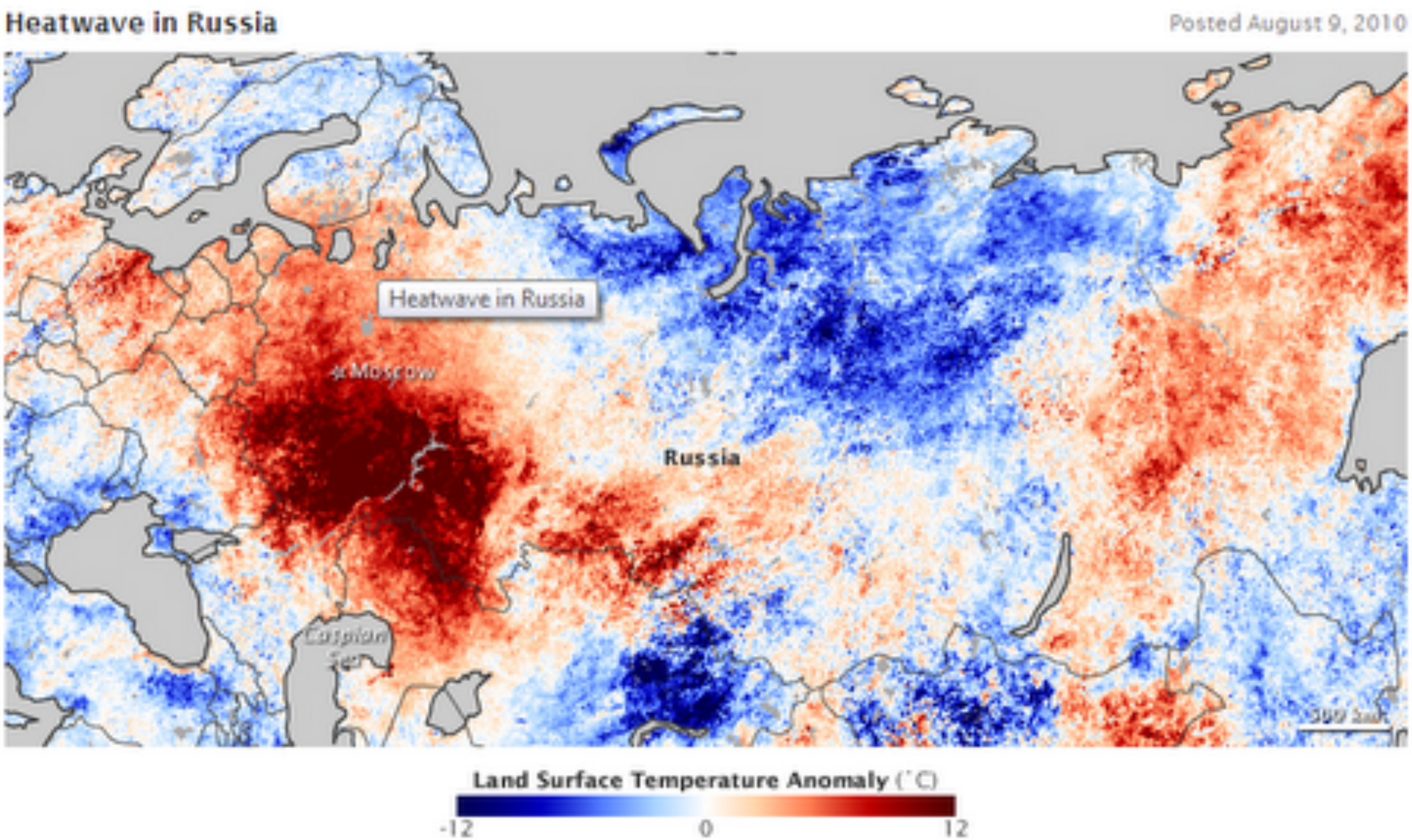
BBC news:

"It's a catastrophe... and that's no overstatement. This will be the biggest disaster in the history of Pakistan"

General Nadeem Ahmed, National Disaster Management Authority

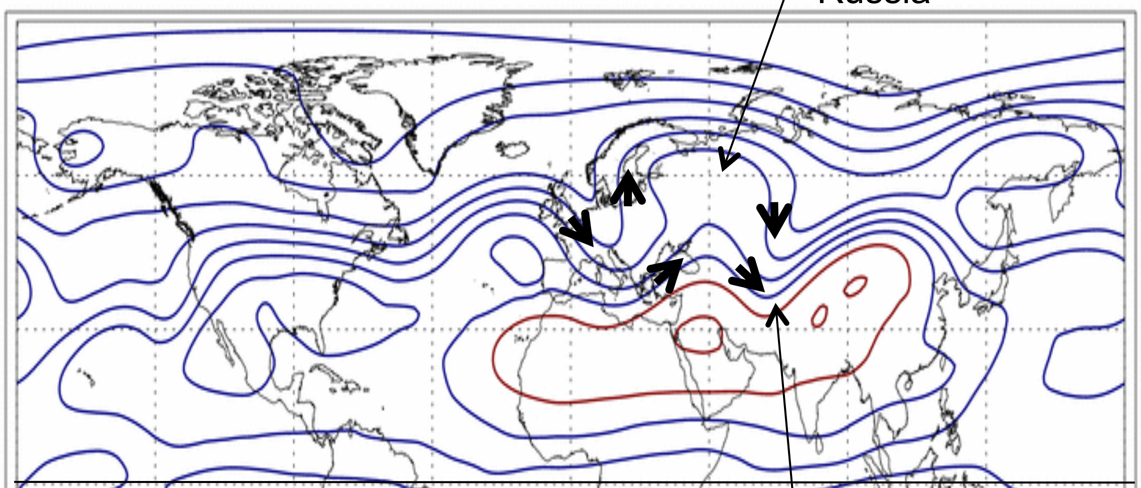
But the Pakistan floods are just one example of unusual extreme events in 2010/2011

‘Russia melted by record heat’ July 2010



The average motion of the air near 12km for 23-30 July 2010

Very warm air over Russia

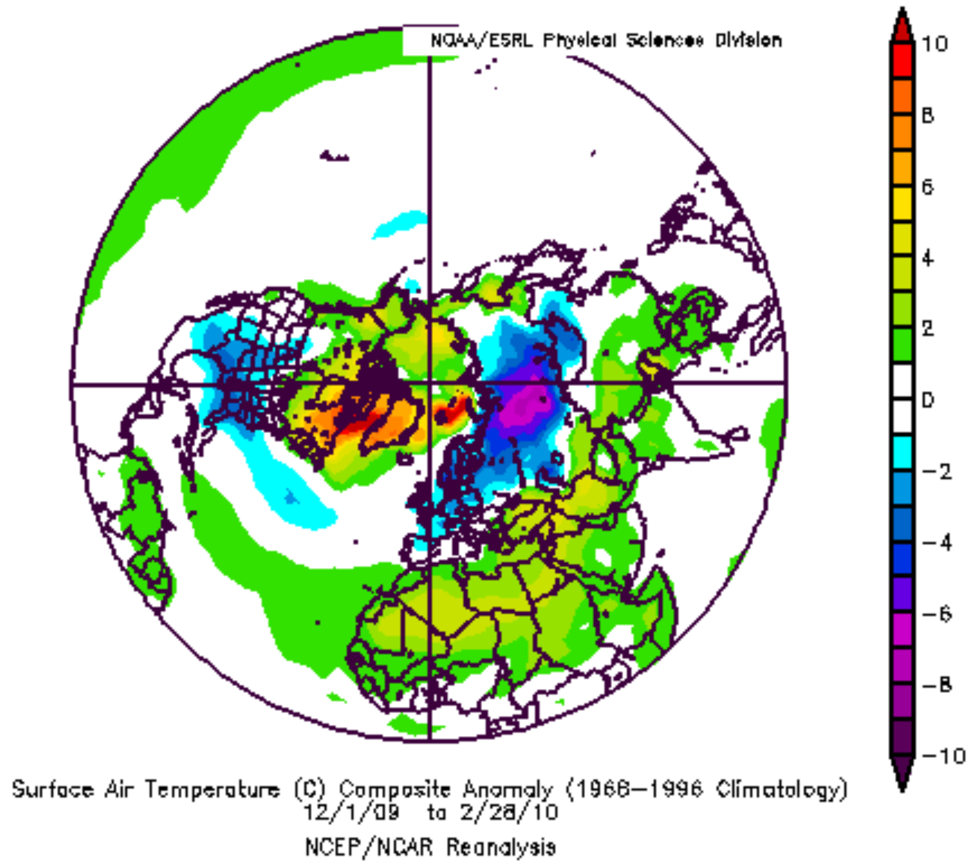


Middle latitude air in the trough extends equatorwards above 'high' in the atmosphere and encourages deep convection to develop in the warm moist monsoon air below it

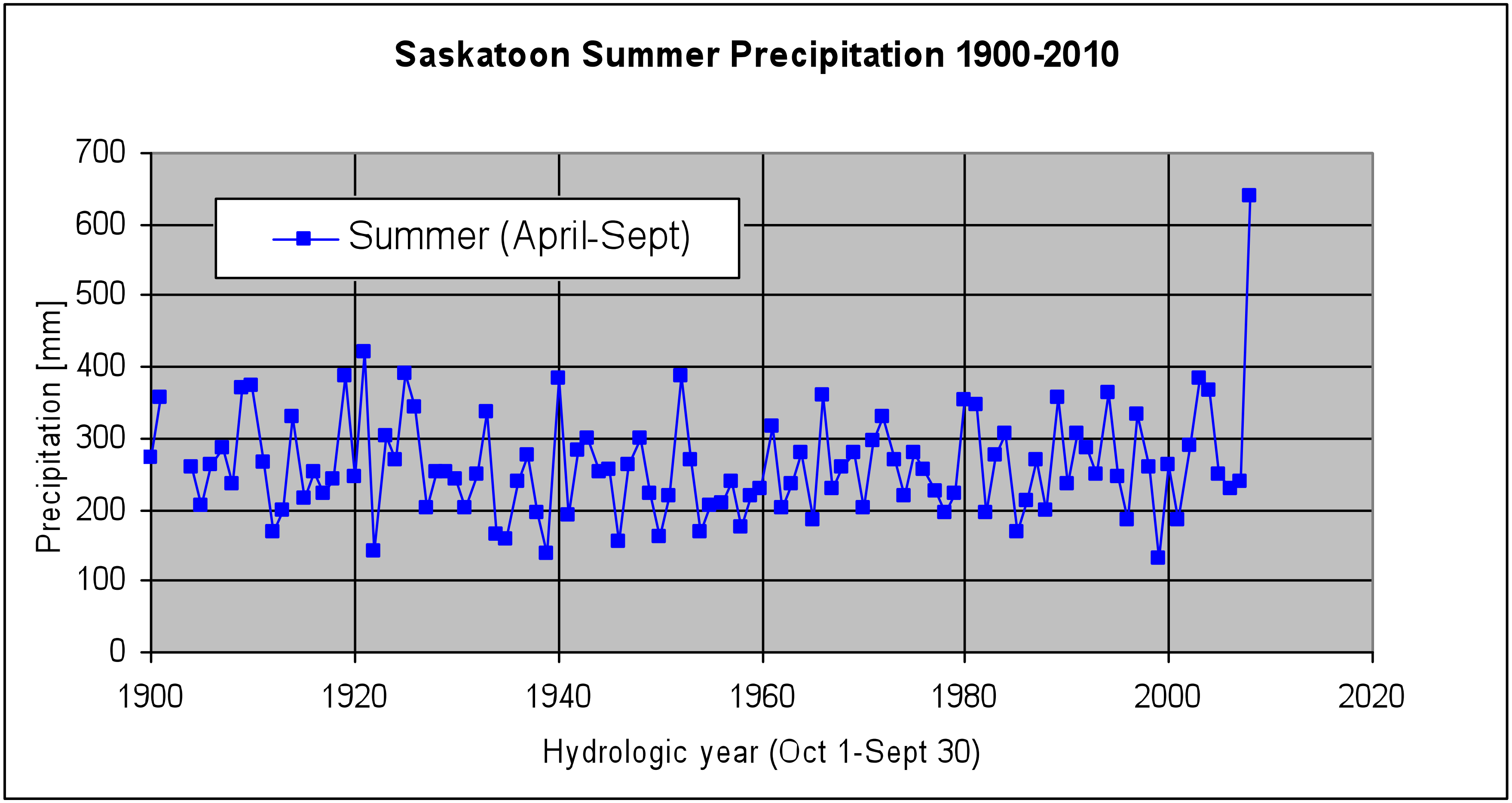
Courtesy of Sir Brian Hoskins

Winter 2009/10 (Dec. – Feb.) Surface Temperature Anomaly

(from 1968-96 climatology)



University of Saskatchewan



Courtesy of Garth van der Kamp

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Is this a signal of climate change?

Global warming is unambiguous; changes to climate and an increase in extremes are confidently expected

Some changes to precipitation and flows are observed

Extreme events are by definition rare – statistical evidence of changes to extremes requires longer runs of reliable data than generally exist; attribution through models generally exceeds modelling capability

But 2010 was a remarkable year for extremes....

- is this 'the writing on the wall'?

Some observations on Saskatchewan

Saskatchewan depends on the South Saskatchewan river

- 75% of South Saskatchewan River water comes from the Rockies (40-50% of basin does not contribute to river flows)
- <1% of flow originates in Saskatchewan, but 70% of population uses river water

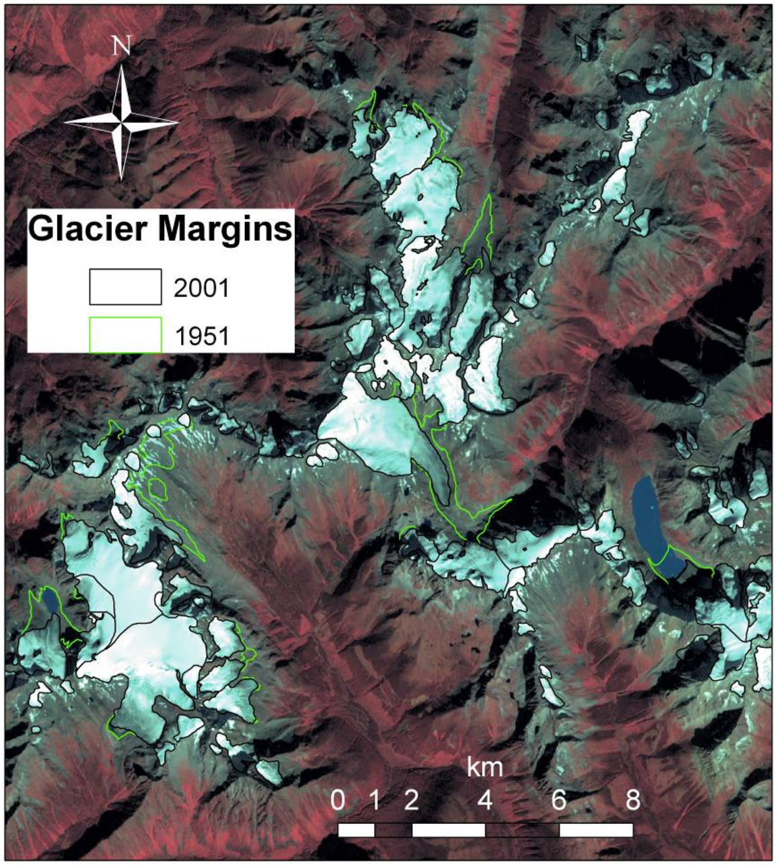
This river is a critically important resource for three provinces, and raises inter-provincial and inter-sector issues (86% of consumption of South Saskatchewan River goes to irrigation).

But:

- The South Saskatchewan river is reaching limits for abstraction
- Pollution is changing its water quality and creating eutrophication
- Climate change is changing the land and its water in complex ways, affecting river flows and prairie hydrology

Some illustrations of change - with thanks to John Pomeroy and Chris DeBeer

Recent Glacier Changes – Western Canadian Cordillera



2001 Landsat 7 false color image (Columbia Mts., British Columbia)

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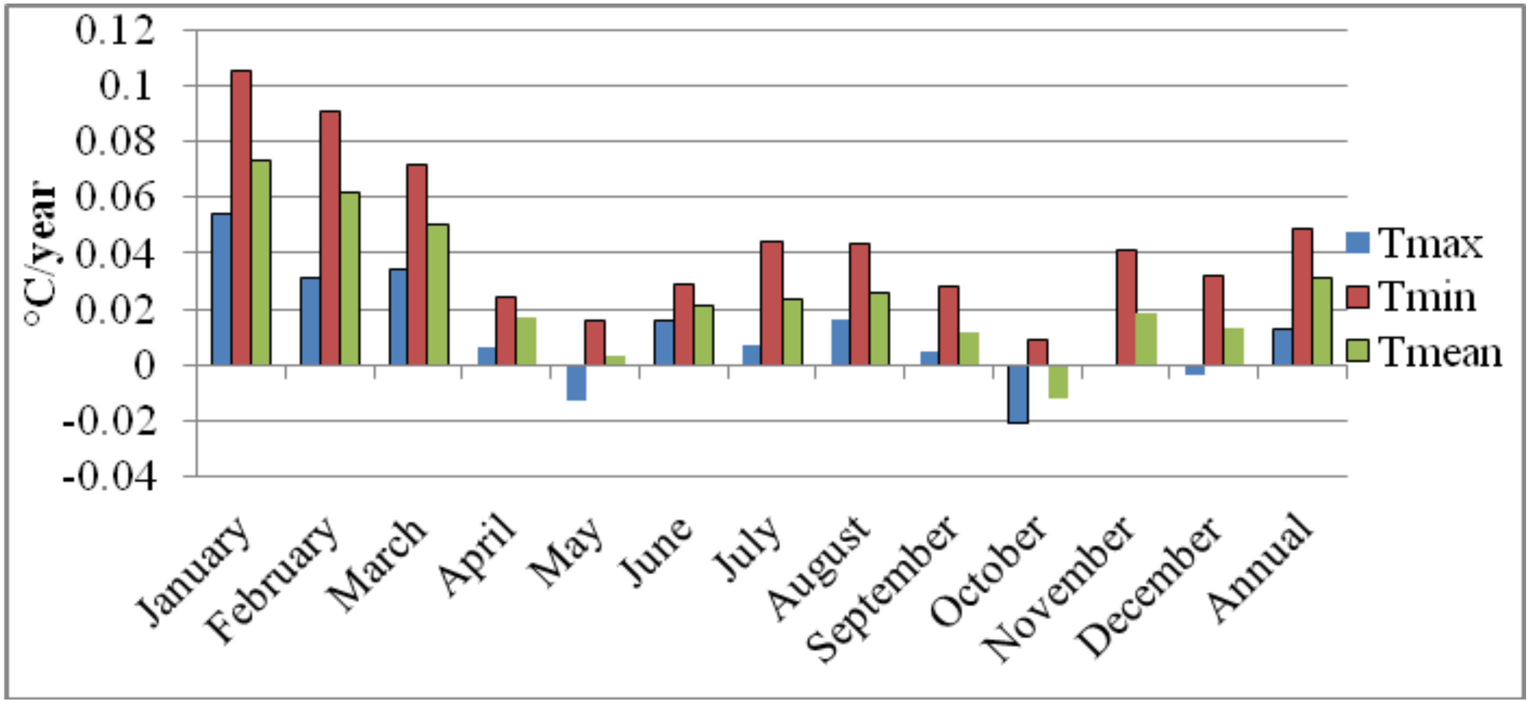
- Glacier retreat and volume loss has been widespread in Western Canada
- Some glaciers have retreated up to 1 – 2 km since early 1950s
- Total glacier covered area has declined by 5 – 15% over the period 1951 – 2001
- The relative loss of ice volume is likely greater than this amount
- Research initiatives such as Western Canadian Cryospheric Network (WC2N) have been investigating these changes

Marmot Creek Research Basin

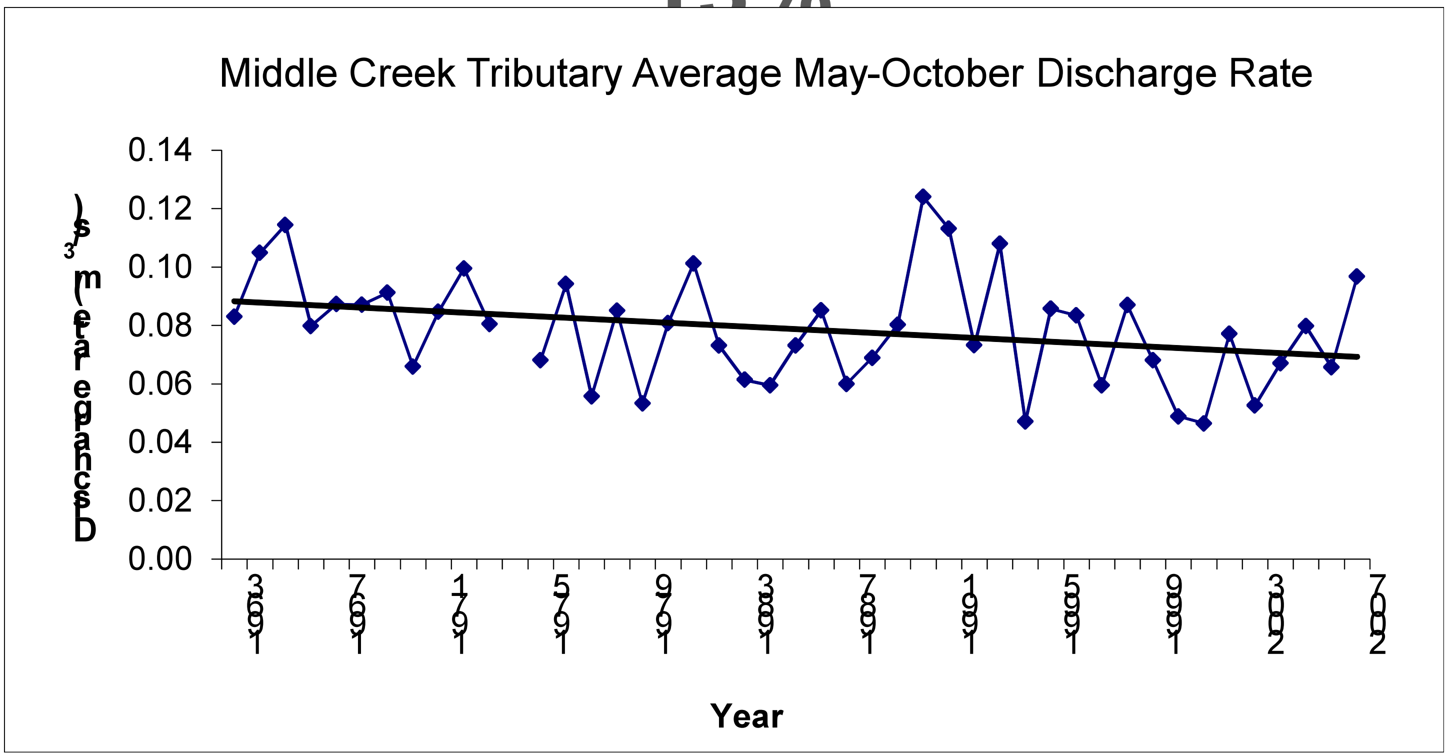
Temperature Trends at Elevation Marmot Creek, 1962-Present



Winters are warmer by 3 to 4 °C since the 1960s

Harder & Pomeroy

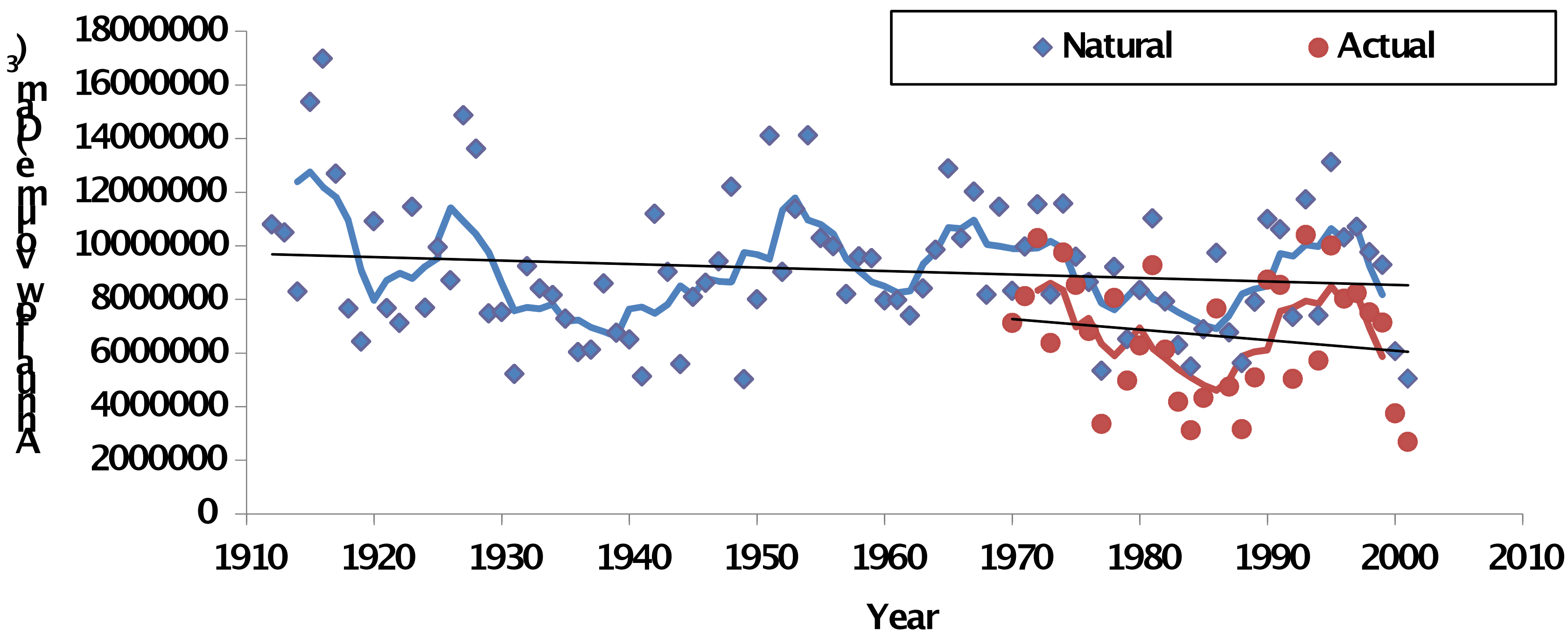
Marmot Creek (1963-2008) Spring-Summer Streamflow decline of ~13%



Significant at 98.3% Confidence Level

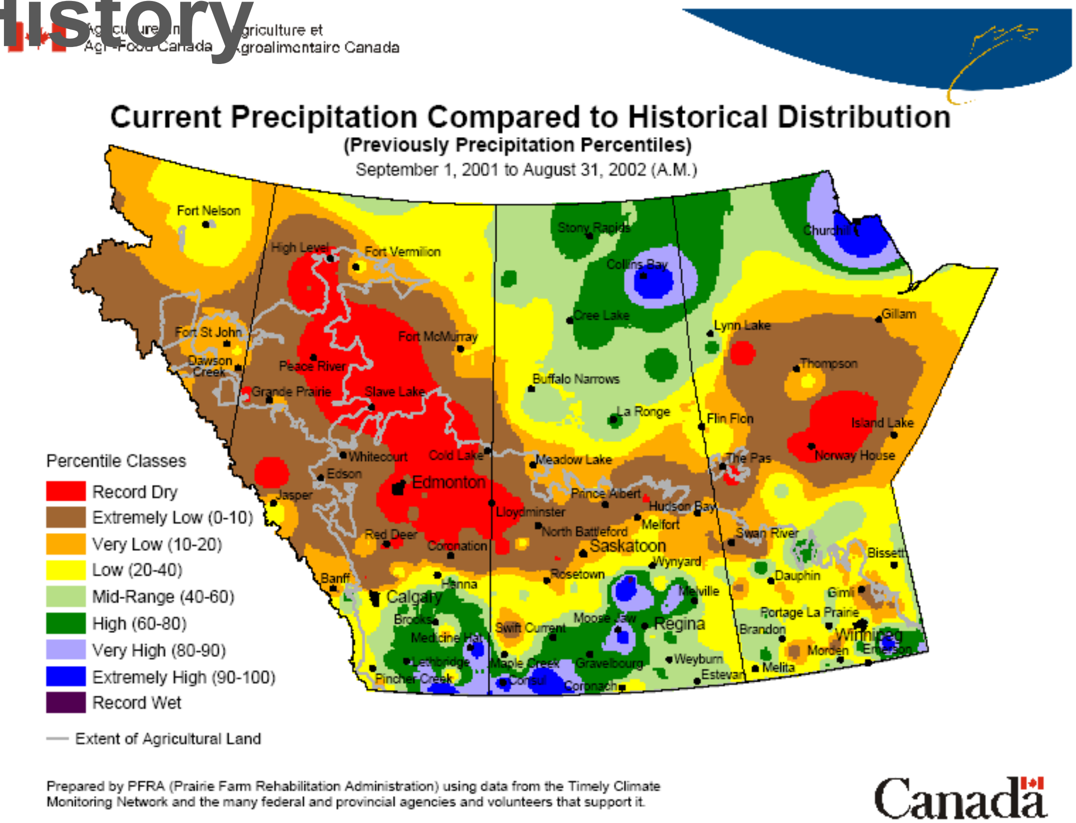
Harder & Pomeroy

South Saskatchewan River – natural and actual flow leaving



Natural flow: 12% decline over 90 years; Actual flow: 15% decline over 30 years

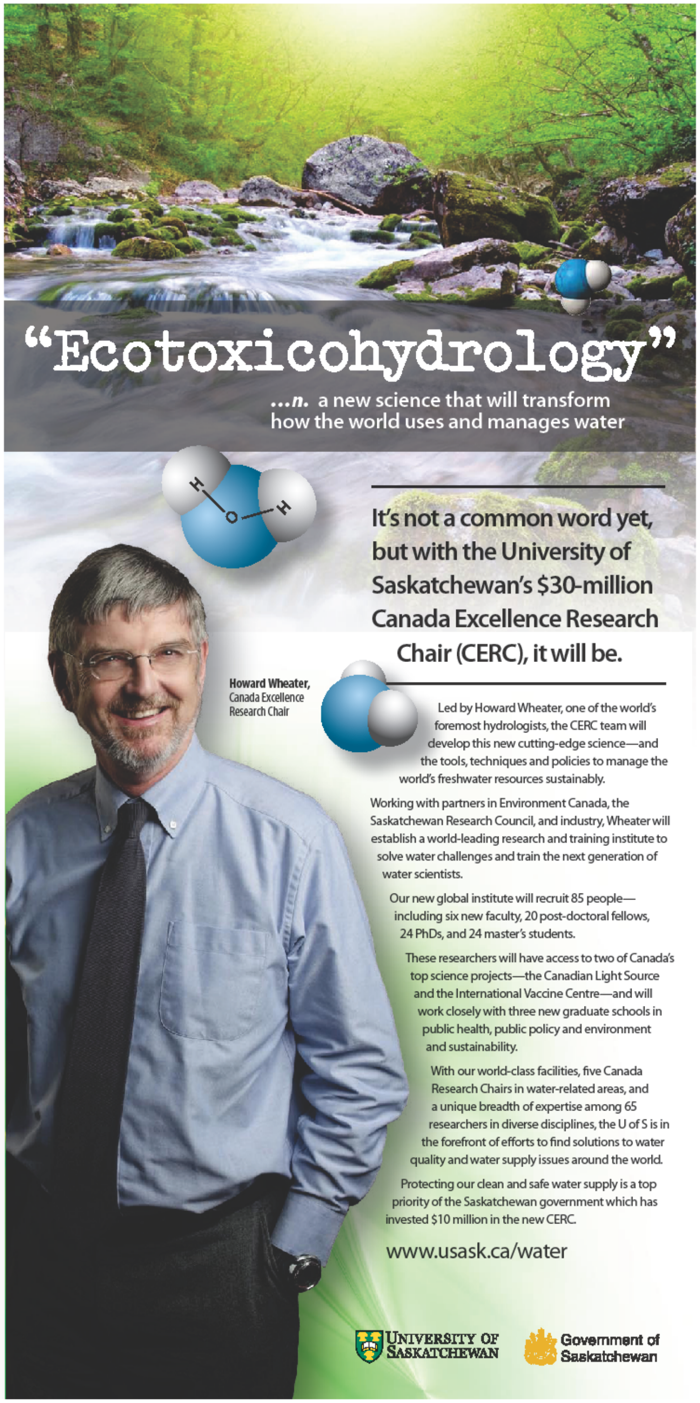
Prairie Drought of 1999-2004
Most Expensive Natural Disaster in Canadian History



- $5.8 billion decline in GDP 2001-2002
- $3.6 billion drop in agricultural production, 2001-2002
- 41,000 jobs lost
- BC, Alberta forest fires
- Saskatchewan dust storms

Some conclusions

- Rocky Mountain water is essential for Prairies' water supply, yet climate is warming, river flows are reducing, and water use is increasing
- Anticipated climate change will dramatically reduce mountain snow water supplies
- Climate warming is shifting snowfall to rainfall over much of the Prairies – longer summers but not more water
- Future climate change is likely to first increase then decrease spring runoff from prairie drainages.
- The prairies are vulnerable to local climate extremes, yet the frequency and intensity of extremes is expected to increase



The CERC at U of S

- 65 Faculty
- 5 Canada Research Chairs
- Partnership with Environment Canada
- $30 million endowment
- Global Institute for Water Security

www.usask.ca

The **CERC** aims to:

- strengthen the science base
- develop new interdisciplinary science
- translate science into decision support tools
- develop Canadian exemplars of generic global issues

The **Global Institute for Water Security** will provide a framework for collaboration, across the University and with Environment Canada and other partners, and will support the development of a broader agenda than the funded CERC programme, including social science, policy and health

The CERC programme themes:

a) ***Climate change and water security***

Canadian exemplar: Saskatchewan River

b) ***Land-water management and environmental change***

Canadian exemplar: South Saskatchewan river

c) ***Sustainable development of natural resources***

Canadian exemplar: oil sands development, remediation and risk assessment

a) Climate change and water security

- Improve understanding of interactions between terrestrial ecosystems and atmospheric processes, and of the impacts of climate variability on water-related ecosystem function;
- Improve the quality of global and regional climatic models and enable better downscaling for water-related climate change impacts assessment;
- Improve assessment of water supply and quality variability, including climate change impacts; and
- Develop new decision support tools for water security analysis to enable policy development.

b) Land-water management and environmental change

Key issues include impacts on the aquatic environment of:

- the effects of agricultural management (e.g. wetland drainage, tillage, irrigation) on hydrological processes (in particular with respect to extremes) and water quality (including salinity)
- point source and diffuse nutrient pollution from agriculture, including the management of fertilizers and manures
- urban discharges of nutrients and (potentially) other chemicals of concern (note: the extent to which we address urban water is an open question)

One focal point for b) is eutrophication of Lake Diefenbaker

c) Sustainable development of natural resources

- Better understand pollutant toxicity on ecological and human health through understanding pollutant toxicity and integrating assessments across terrestrial and aquatic ecosystems;
- Develop integrated decision-support tools for risk assessment and remediation of contaminated land and water, including biodegradation and sequestration of pollutants; and
- Support new assessment and remediation technologies through better understanding of interactions among hydrology, ecotoxicology, water quality and wetland ecology, including potential for bioremediation in the subsurface (both soil and groundwater) and in wetlands.

Saskatchewan River Basin

Location of potential theme a and b research sites within Saskatchewan River basin

In conclusion:

The problems society now faces with respect to water security are complex and multi-faceted.

New science, technologies and modelling tools are needed to enable society to understand and manage change, to enable politicians and managers to make the hard choices required for water management and environmental protection.

Our goal is to develop these, for application to Canada and the world.